



Insight into the Dielectric Breakdown of Elastomers

Vaicekauskaite, Justina; Mazurek, Piotr; Yu, Liyun; Skov, Anne Ladegaard

Publication date:
2018

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Vaicekauskaite, J., Mazurek, P., Yu, L., & Skov, A. L. (2018). *Insight into the Dielectric Breakdown of Elastomers*. Abstract from 8th International Conference on Electromechanically Active Polymer (EAP) Transducers & Artificial Muscles (EuroEAP 2018), Lyon, France.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Insight into the Dielectric Breakdown of Elastomers

Justina Vaičekauskaitė, Piotr Mazurek, Liyun Yu, Anne Ladegaard Skov

Nowadays, dielectric elastomers are used in many different fields, such as: dielectric or transport layers, modern devices or flexible electronics [1]. To test dielectric elastomer stability in electric field, dielectric breakdown measurements are used. These measurements have been used over many years and still gaining on importance, however, fundamentals behind the electrical breakdown of thin and elastic films are still not fully understood and elucidated.

There are only few theoretical models that assess the physical processes occurring during a breakdown phenomenon, for example: the hole-induced breakdown model, the electron-trapping breakdown model, the resonant-tunneling-induced breakdown model and the filamentary model [2]. In all these theories, electrons movements from electrode to polymer film samples are considered. Other theory is the, so-called, electro-mechanical model, which implies that polymer films are not always smooth, and when an electric field is applied, the force gets bigger at the thinnest spot of the film, which causes the deformation of a film. Subsequently, when electric strength is reached at the thinnest spot - breakdown occurs [3]. This is also referred to electro-mechanical instability (EMI) and has been extensively studied by modelling [4]–[7].

In this work, microscopic processes taking place during the dielectric breakdown were captured using high-speed camera, to verify if the time-scale and behavior of the electrical breakdown can elucidate the underlying behavior.

- [1] V. A. Zakrevskii and N. T. Sudar, 'Electrical Breakdown of Thin Polymer Films', *Phys. Solid State*, vol. 47, no. 5, p. 961, 2005.
- [2] A. Belkin, A. Bezryadin, L. Hendren, and A. Hubler, 'Recovery of Alumina Nanocapacitors after High Voltage Breakdown', *Sci. Rep.*, vol. 7, no. 1, p. 932, 2017.
- [3] J. Blok and D. G. Legrand, 'Dielectric breakdown of polymer films', *J. Appl. Phys.*, vol. 40, no. 1, pp. 288–293, 1969.
- [4] X. Zhao and Z. Suo, 'Theory of dielectric elastomers capable of giant deformation of actuation', *Phys. Rev. Lett.*, vol. 104, no. 17, pp. 1–4, 2010.
- [5] J. Huang, T. Lu, J. Zhu, D. R. Clarke, and Z. Suo, 'Large, uni-directional actuation in dielectric elastomers achieved by fiber stiffening', *Appl. Phys. Lett.*, vol. 100, no. 21, 2012.
- [6] X. Zhou *et al.*, 'Electrical breakdown and ultrahigh electrical energy density in poly(vinylidene fluoride-hexafluoropropylene) copolymer', *Appl. Phys. Lett.*, vol. 94, no. 16, pp. 92–95, 2009.
- [7] G. Zurlo, M. Destrade, D. DeTommasi, and G. Puglisi, 'Catastrophic Thinning of Dielectric Elastomers', *Phys. Rev. Lett.*, vol. 118, no. 7, 2017.